SEABIRDS IN THE GULF OF CALIFORNIA: A VULNERABLE, INTERNATIONAL RESOURCE

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INTRODUCTION

The Gulf of California and its associated islands (Figure 1, Table 1) are thought to be—and are popularized to be—areas still largely unaffected by man. Based on our experiences in the Gulf of California from 1970 to 1975, this popular misconception is certainly not true. There is no doubt that the Gulf is an area of fantastic aesthetic potential, and this is a resource which can and should be exploited by Mexican tourism. In order to survive, however, an aesthetic resource also requires protection so that it can be a continuing one for future generations.

An important aspect of tourism requires the natural properties of an environment that is relatively undisturbed, unpolluted, and rich in native flora and fauna. The marine birds are an important part of the total Gulf of California resource. They deserve consideration in any future conservation programs. This meeting and others like it surely illustrate a concern for the Gulf of California and its varied resources—and for marine ecosystems throughout North America.

Our discussion here will provide a brief overview of the marine bird resource, the seabirds. We will (1) briefly describe the resource and estimate its extent, (2) discuss some conservation problems, and (3) suggest some conservation efforts.

THE SEABIRD RESOURCE

What is a Seabird?

The "seabirds" are comprised of such diverse taxonomic groupings that it is difficult to separate out or categorize for management purposes any particular group. Nonetheless, here we will discuss those

The U.S. Fish and Wildlife Service, Denver Wildlife Research Center, and Departamento de la Fauna Silvestre, Mexico City, made our studies in the Gulf of California possible. Jeanne E. Cardana did our drawings.

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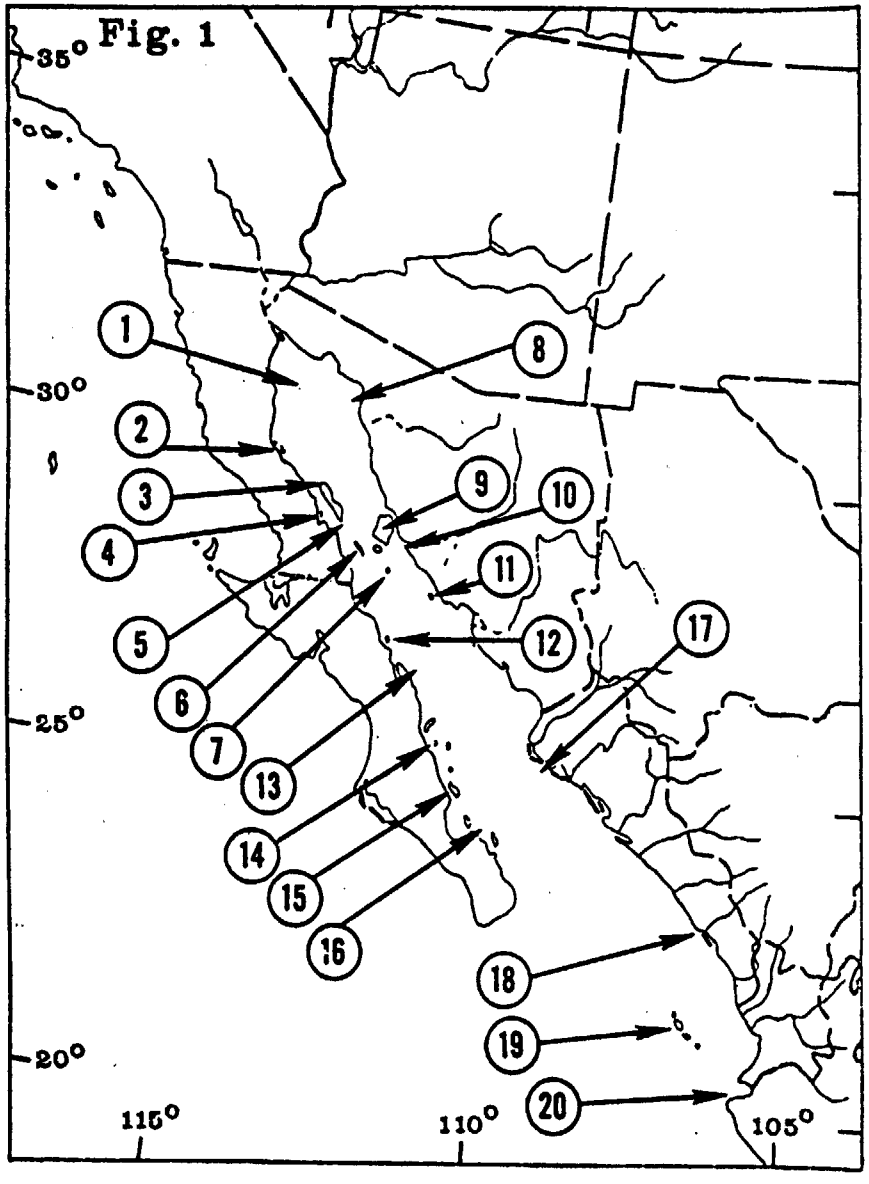

FIGURE 1

Map of the Gulf of California. Locations are numbered and given in Table 1.

special characteristics and problems of conservation involved with marine birds. It should always be kept in mind that true conservation effort requires a habitat and ecosystem approach.

Here, for discussion purposes we will consider seabirds as those birds that occupy salt- or brackish-water environments for at least a part of their annual cycle. For the Gulf of California, this includes just about every species of bird that is not terrestrial; but, it is in keeping with the loose definition of "seabird" as proposed by the Pacific Seabird Group.[1]

Most seabirds that breed in the Gulf of California nest in concentrated island colonies; they share the upper layers of the ocean surface in diverse feeding strategies.[2] Therefore, seabirds as a rule are particularly vulnerable to outside disturbances (colonialism importantly evolved as a predator-avoidance mechanism), pollution, and unnatural environmental changes.

Extent and Abundance of Marine Birds—Brief Review

It is readily apparent from the information available to us that the Gulf of California offers the most spectacular concentrations of nesting, southern seabirds on the West Coast of North America. The Sea of Cortez is unique on that basis. Often spectacular elements of the Gulf of California avifauna occur, as well as transient seabirds. Both resident and transient seabirds of the Gulf of Californina in almost all cases are truly international in distribution.

Five species of seabirds (Craveri's Murrelet [*Endomychura craveri*], Brown Booby [*Sula leucogaster*], Yellow-footed Western Gull [*Larus occidentalis*], Heermann's Gull [*Larus heermani*], and Elegant Tern [*Thalasseus elegans*]) are known to be almost solely restricted in breeding range to islands off Baja California and mostly to the Gulf of California. These birds can be considered as endemic to the Gulf of California. Future studies may reveal additional endemics as species, subspecies, or demes, such as the Black and Least Petrels (*Oceanodroma melania* and *Halocyptena microsoma*, both of which have disjunct distributions in the northern part of the Gulf). The Craveri's Murrelet is the southernmost alcid known in North America, with affinities from Arctic waters.[3] The Heermann's Gull[4] and possibly also

1. Pacific Seabird Group, *Formation and Goals*. 1 Pacific Seabird Group Bull. 2 (1974).
2. N. P. Ashmole, *Sea Bird Ecology and the Marine Environment*, 1 Avian Biology 224-34 (1971).
3. M. D. F. Udvardy, *Zoogeographical Study of the Pacific Alcidae*, Pac. Basin Geog. Symposium 85-111 (1963).
4. T. R. Howell, B. Araya, & W. R. Miller, *Breeding Biology of the Gray Gull, Larus modestus*, 104 Univ. Calif. Publ. Zool. 48-52 (1974).

TABLE 1

Major Offshore Islands and Offshore-Island Areas in the Gulf of California

MEXICAN STATE:[1] *No.*[2]	*Location*	*Approximate Lat.-Longi.*	*Additional Information–Remarks*
BAJA CALIFORNIA NORTE, EAST COAST:			
1	Northern Gulf	3107-11430	2 offshore rocks–Rocas Consag.
2	San Luis Gonzaga area	3000-11427	5 islands–Huerfanito, Miramar, Colorado, Cholluda, San Luis; 2 smaller islands.
3	North Angel de la Guarda	2934-11354	4 islands–Angel de la Guarda,[3] Mejia, Pelicano, Granito; 3 smaller islands.
4	Bahia de los Angeles	2900-11330	6 major islands–Smith, Ventana, Piojo, Cabeza de Caballo, Los Gemelos; 10 smaller islands.
5	South Angel de la Guarda	2904-11307	1 island–Estanque.
6	Midriff area	2842-11256	6 islands–San Esteban,[3] Cardinosa, Rasa, Salsipuedes, Las Animas, San Lorenzo; 4 smaller islands.
7	Mid-central Gulf	2823-11221	1 island–San Pedro Martir.
SONORA, WEST COAST:[4]			
8	Northeast Gulf	3101-11314	1 island–San Jorge; 2 smaller islands.
9	Isla Tiburon area	2900-11220	4 islands–Tiburon,[3] Patos, Turner, Cholla.
10	Bahia de Kino	2849-11158	1 island–Alcatraz.
11	Guaymas area	2758-11122	1 island–San Pedro Nolasco; 4 smaller islands.
BAJA CALIFORNIA SUR, EAST COAST:			
12	Santa Rosalia area	2715-11205	3 islands–Tortuga, San Marcos,[3] Santa Inez; 3 smaller islands.
13	Bahia Concepcion area	2640-11140	1 island–San Ildefonso; 3 smaller islands.
14	Isla Carmen area	2550-11110	5 islands–Coronados, Carmen,[3] Danzante, Monserrat, Santa Catalina; 9 smaller islands.
15	Isla San Jose area	2500-11037	3 islands–Santa Cruz, San Jose,[3] San Francisco; 5 smaller islands.
16	La Paz area	2420-11010	3 islands–Partida,[3] Espiritu Santo,[3] Cerralvo;[3] 5 smaller islands.
SINALOA COAST:[4]			
17	Topolobompo area	2526-10923	1 island–Farallon San Ignacio.
18	Mazatlan area	2312-10630	4 islands–de Lobos, de Venados, de Pajaros, del Cardon.
NAYARIT COAST:			
19	Tres Marias area	2130-10630	5 islands–San Juanico, Tres Marias,[3] Isabela; 4 smaller islands.
JALISCO COAST:			
20	Puerto Vallerta area	2044-10534	3 islands–Tres Marietas; 3 smaller islands.

1. Determined in part from Cuadernos de Documentacion Secretaria de la Presidencia, Direccion General Documentacion e Informe Presidencial, Baja California Hoy 16 (1974).
2. This number corresponds with Figure 1.
3. These are larger islands over about 20 km² in area.
4. In the region of central Sonora (south of Guaymas) and south, offshore, rocky islands are few. However, habitat gradually changes to mangrove-estuary type with many mangrove islands, barrier islands, and sandy, river-mouth islands. These are not included in this tabulation.

the Yellow-footed Western Gull[5] have close taxonomic relatives only as near as the Peru Current.

Other nesting seabirds (Blue-footed Booby [*Sula nebouxii*], Red-billed Tropicbird [*Phaeton aethereus*], Magnificient Frigatebird [*Fregata magnificens*], Sooty Tern [*Sterna fuscata*], and others) extend their breeding ranges no farther north on the Pacific Coast than Baja California. Yet other species in the Gulf of California (Osprey [*Pandion haliaetus*][6] and California Brown Pelican [*Pelecanus occidentalis*][7]) are reduced in numbers in areas outside the Gulf.

We present here several illustrations of nesting distributions in the Gulf of California to show (1) the localized or endemic nesting distribution (Heermann's Gull and Yellow-footed Western Gull; Figures 2A and 2B), and (2) nesting distributions with the Gulf of California or Baja California as a "stronghold" area of a species' breeding distribution (California Brown Pelican and Osprey; Figure 3A and 3B).

Migratory waterfowl (Anseriformes—ducks and geese, Charadriiformes—shorebirds) are also considered as seabirds, since in winter, most in the area of the Gulf of California are found in brackish waters. The coastal marshes of Sonora-Sinaloa are becoming increasingly important Mexican wintering areas for waterfowl and shorebirds as inland lagoons become less numerous.[8] The distributions of ducks and geese in the region of the Gulf of California are summarized by A. S. Leopold and F. C. Bellrose.[9]

The Pacific Black Brant (*Branta bernicula nigricans*), the most pelagic of the wild geese, appears to be expanding its wintering range into the northern part of the Gulf of California, when only recently it has expanded into the Sinaloa and southern Sonora coastal areas.[10] Presently, such areas as the Estero de Kino and Canal de Infiernillo may be fast becoming important early-winter staging areas for substantial numbers of Pacific Black Brant.

The migratory waterfowl resource is deserving of a full presentation here, including a discussion of special conservation problems of hunted species. This resource has, on the other hand, already been

5. R. LeValley, *The Plumage Sequence and Voice of the Yellow-footed Western Gull (Larus occidentalis livens) with Comments on the Taxonomic Implications of These Characters*, 2 Pacific Seabird Group Bull. 33-34 (1975).

6. C. J. Henny, *Research, Management, and Status of the Osprey in North America*, World Conference on Birds of Prey (in press 1976).

7. J. R. Jehl, Jr., *Studies of a Declining Population of Brown Pelicans in Northwestern Baja California*, 75 Condor 69-79 (1973).

8. A. S. Leopold, Wildlife in Mexico: The Game Birds and Mammals (1959).

9. *Id. See also* F. C. Bellrose, Ducks, Geese and Swans of North America (1976).

10. *See* note 8 *supra*. *See also* R. H. Smith & C. H. Jensen, *Black Brant on the Mainland Coast of Mexico*, 35 Trans. North Am. Wildl. Nat. Res. Conf. 227-41 (1970).

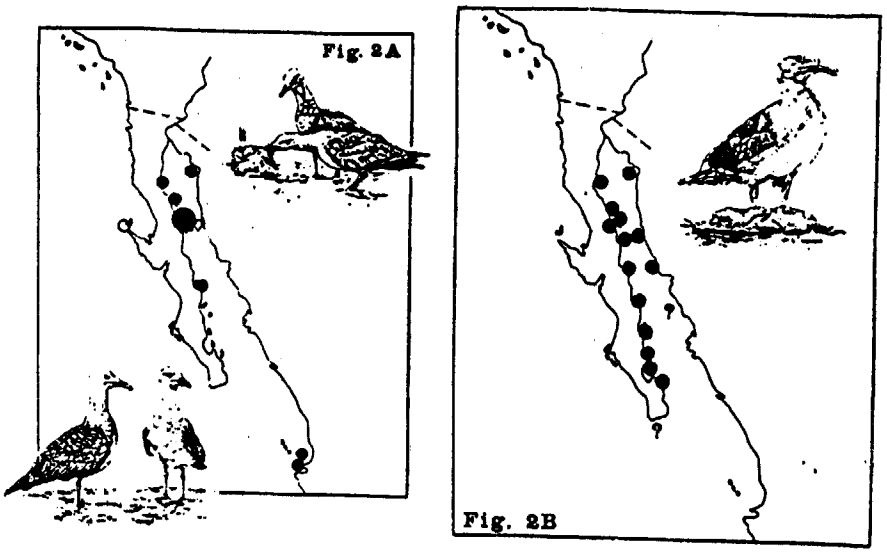

FIGURE 2

A. Distribution of breeding colonies of Heermann's Gulls. The sizes of the circles represent the sizes of the colonies: open circle = colony size of less than 10 pairs; small, closed circle = colony size of up to 200 pairs; and large, closed circle = Rasa Island where colony size is around 50,000 pairs. The gulls in the top right are attacking a chick that has wandered into their territory. *B.* The approximate distribution of the Yellow-footed Western Gull. Since this species does not nest in large colonies, its density depends upon the amount of shoreline habitat available in the Gulf of California.

given serious management consideration by the Mexican government.[11] The marine birds other than waterfowl are mostly neglected.

CONSERVATION OF MARINE BIRDS

Need for Conservation

Ultimately and when economically minded people are around, the question is asked: "Why conserve seabirds?" Since marine bird resources have been mostly neglected by resource managers in most of western North America until recently,[12] few scientific data are available to answer that question from a purely economic viewpoint. Actually, the question is irrelevant if people *want* to conserve the

11. M. L. Cossio, *Administración de la Fauna en Zonas Aridas: Golfo de California*, 16 NRJ 535 (1976).

12. L. W. Sowl & J. C. Bartonek, *Seabirds—Alaska's Most Neglected Resource*, 39 Trans. North Am. Wildl. Nat. Res. Conf. 117-26 (1974).

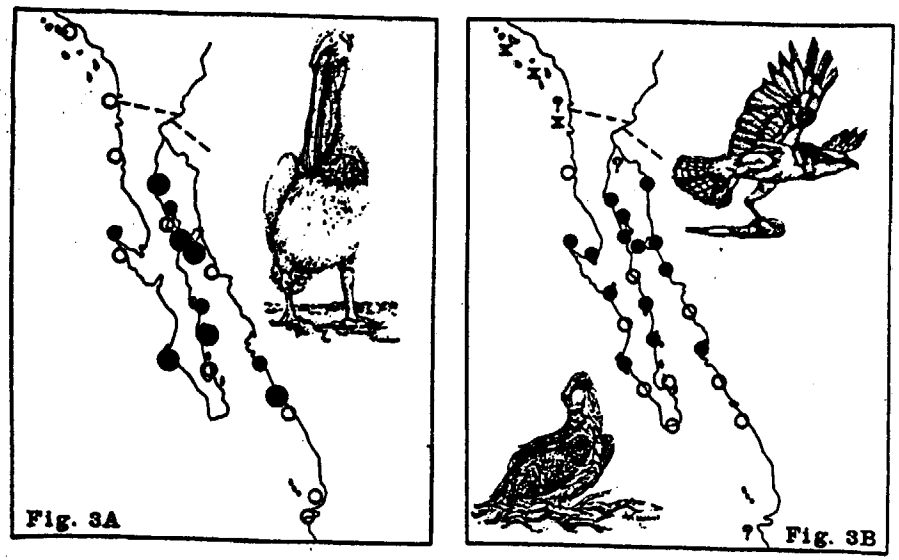

FIGURE 3

A. Distribution of colonies of the California Brown Pelican. The sizes of the circles indicate the sizes of the colonies: small, open circles = < 500 pairs; small, closed circles = 500 to 3,000 pairs; and large, closed circles = > 3,000 pairs. *B.* Approximate distribution of the Osprey. Although certain areas contain higher concentrations than others, the species is widespread. Closed circles indicate areas where higher concentrations occur, open circles indicate areas of lesser density, and X's indicate populations no longer in existence.

resource, even if we do desire to answer the many questions surrounding seabird ecology and the role of seabirds in marine habitats. Secondly, it is irresponsible to not conserve marine birds and their habitats just because we cannot or do not consume or directly utilize most species, or just because they are not hunted.

Nisbet,[13] who summarized a recent conference on the conservation of marine birds in northern North America simply stated: ". . . (conservation) in fact represents the future, and as biologists it is our duty to promote it." Lindsay[14] also expressed his feelings after many years of travel in Baja California: ". . . conservation is an international problem and wildlife is an international resource. It seems appropriate for us to encourage the proper protection of areas and values in Baja California. . . ."

13. I. C. T. Nisbet, *Conservation of Marine Birds in Northern North America—A Summary*, Cons. Marine Birds in North Am. (in press 1976).

14. G. Lindsay, *Some Natural Values of Baja California*, 23 Pacific Discovery 1-10 (1970).

As biologists, we surely want to conserve the resources of the Gulf of California as a total unit; and as biologists, our recommendations are biologically, not politically, motivated. On the other hand, we also believe that this marine resource, which includes the seabirds, is a potential economic asset to Mexico, indirectly perhaps through nutrient cycling[8] (a subject on which literally nothing is known), directly through guano marketing,[15] and again indirectly as aesthetic components of tourism and as educational experiences for university students in Mexico and the United States alike.

The Pacific Seabird Group has also expressed a concern for the conservation of marine birds in the Gulf of California.[16] Additional concern for the Gulf of California and its fauna has been expressed by the American Ornithologists' Union,[17] and the Cooper/Wilson Ornithological Societies.[18] Concern for the Gulf of California in Mexico is also dramatically illustrated in several articles in a recent issue of *"Supervivencia."*[19]

Existing Conservation Measures for Seabirds

In 1972, the 1936 Convention between the United States and Mexico[20] for the Protection of Migratory Birds and Game Mammals (50 Stat. 1311) was amended to include 32 additional families of birds to be afforded international protection, especially from wanton shooting. The earlier convention protected mainly the migratory waterfowl and shorebirds. This agreement was formulated between the U.S. Fish and Wildlife Service and the Departamento de la Fauna Silvestre; and, of the 32 new families added to the protected list, 20 have important seabird or other marine/estuarine species resident or transient in the Gulf of California (Table 2). Recently (October 1975), the same two agencies entered into an agreement to conduct cooperative wildlife management and research in Mexico, including the Gulf of California,[21] and it is hoped that significant steps can be

15. B. F. O. Tafall, *La Expedición del M.N. "Gracioso" por Aguas del Extremo Noroeste Mexicano*, 3 Anales de la Esc. Nac. de Ciencias Biológicas 331-60 (1944).

16. Pacific Seabird Group, *Seabird Conservation in the Gulf of California*, 1 Pacific Seabird Group Bull. 24-26 (1974).

17. American Ornithologists' Union Conservation Committee (S. M. Russell, Chairman), Bird Conservation in Middle America—Report of the A.O.U. Conservation Committee, 1972-73, 90 Auk 883-84 (1973).

18. R. A. Ryder (Chairman), *Report of the Joint Resolutions Committee*, 87 Wilson Bull. 582 (1975). A large part of the 37 Trans. North Am. Wildl. Nat. Res. Conf. was devoted to conservation problems in Mexico, and we suggest review of pages 4-18, 57-99, and 391-94.

19. Bioconservación, *El Golfo de California, un Recurso Mexicano de Importancia Internacional*, 1 Supervivencia 13-22 (1975), and Bioconservación, *Derechos Soberanos de México en el Golfo de California*, 1 Supervivencia 28 (1975).

20. *See* note 8 *supra*.

21. U.S. Dept. of Interior, *Mexican-American Wildlife Management Signed*, New Release (Albuquerque, New Mexico) (20 Oct. 1975).

TABLE 2

Names of Gulf of California Seabird Families Given Additional Protection Under 1972 Amendments to the 1936 Wildlife Convention with Mexico[1]

Family Name	*English Name of Gulf of Calif. Inclusions*	*Spanish Name*
ALCEDINIDAE	Kingfishers	Martins Pescador
ALCIDAE	Murrelets	Patos de Noche
ARDEIDAE	Herons, egrets	Garzones, Garzas
FREGATIDAE	Frigatebirds	Fregatas, Tijeretas
GAVIIDAE	Loons	Somorgujos
HAEMATOPODIDAE	Oystercatchers	Ostreros
HYDROBATIDAE	Storm Petrels	Petreles
LARIDAE	Gulls, Terns	Gaviotas, Gallitos
PANDIONIDAE	Ospreys	Gavillanes Pescador
PELECANIDAE	Pelicans	Pelicanos, Alcatrazes
PHAETHONTIDAE	Tropicbirds	Rabas de Junco
PHALACROCORACIDAE	Cormorants	Corvejones, Cormoranes
PODICIPEDIDAE	Grebes	Zambullidores, Buzos
PROCELLARIIDAE	Shearwaters	Fulmaros
RYNCHOPIDAE	Skimmers	Rayadores
STERCORARIIDAE	Jaegers	Estercorarios
SULIDAE	Boobies	Bubias
THRESKIORNITHIDAE	Spoonbill, Ibises	Teoquechol, Cuchareras

1. From Federal Register, Doc. 72-6939, 5/5/72; 32 families in total were included in that agreement.

taken to expand the protection and management of wildlife (including marine birds) and wildlife habitat in future years.

The U.S. Fish and Wildlife Service has also published a list of "endangered fauna" in the United States[22] under the Endangered Species Act of 1973 (Public Law 93-205, 87 Stat. 884). Here, ". . . the United States has pledged its support for the conservation of wild flora and fauna worldwide." Four subspecies on the list occur in the Gulf of California: Brown Pelicans (*Pelecanus occidentalis californicus*), American Peregrine Falcon (*Falco peregrinus anatum*), California Least Tern (*Sterna albifrons browni*), and Yuma Clapper Rail (*Rallus longirostris yumanensis*). Additionally, the National Audubon Society publishes a "blue list" of species believed to be declining at least locally somewhere in the United States. In 1975, of 51 species listed,[23] 13 occur commonly in the Gulf of California (including the coastal estuaries).

In general, little formal protection is presently afforded nesting seabirds in the Gulf of California; but, Isla Rasa (Figure 1, Table 1) is

22. U.S. Dept. of Interior, United States List of Endangered Fauna, May 1974 (1974).
23. R. Arbib, *The Blue List for 1975*, 28 Am. Birds 971-74 (1974).

one outstanding exception—and a model for future sanctuaries. Through the combined efforts of the Departamento de la Fauna Silvestre, National Audubon Society, Arizona-Sonora Desert Museum, and California Academy of Sciences, this outstanding "National Reserve and Refuge of Migratory Birds" was established by the Mexican government in 1964.[24] This was a major step forward, but as will be seen later, is but a first step in the conservation of the total marine fauna. The Rasa Island refuge is meant to protect nesting populations of (1) Heermann's Gulls, where perhaps over 90 percent of the total species nests[25] (2) Elegant Terns, where again the majority of the species nests,[26] and (3) small numbers of Royal Terns (*Thalasseus maximus*) which breed also elsewhere. Walker[27] and Barreto[28] reported that commercial egg harvesting resulted in serious population declines of all three species on Rasa from the early 1950s through the early 1960s, and that was probably the most urgent conservation problem at the time of the establishment of the refuge. The continued effectiveness of the refuge, however, depends on the insurance of a non-disturbance situation on the island during the breeding season. Unfortunately, the island is becoming a more and more popular stopping point for tourists. Human disturbances are probably still the most urgent conservation problem today, although not the only problem.

PRESENT AND POTENTIAL CONSERVATION PROBLEMS

Disturbances to Nesting Colonies

The adverse effects of human disturbances on colony-nesting birds are well known and well documented. Instances recorded in the literature go back almost as early, or earlier, than the study of birds itself (see review by Bourne).[29] Human disruptions have traditionally been either intentional, such as direct overharvesting of eggs or birds,[30] or more recently, unintentional such as already suggested at Rasa Island. Fortunately, human pressures like these are the most obvious and easily recognized conservation problems, and perhaps the easiest to manage.

24. Bernardo Villa-Ramirez, personal communication. *See also* L. W. Walker, *Baja's Island of Birds*, 18 Pacific Discovery 27-31 (1965).
25. R. T. Orr, Animals in Migration 150 (1970).
26. American Ornithologists' Union, Check-list of North American Birds 240-41 (1957).
27. L. W. Walker, *Sea Birds of Isla Raza*, 99 Nat. Geog. Mag. 239-48 (1951).
28. R. Barreto, *Isla Rasa, B. C., Refugio de Gaviotas y Gallitos del Mar*, 10 Bosques y Fauna 3-8 (1975).
29. W. R. P. Bourne, *General Threats to Seabirds*, 11 Int. Council for Bird Preserv. Bull. 200-18 (1972).
30. *Id.*

To provide some examples, most of our disturbance data that relate directly to the Gulf of California pertain to the Heermann's Gull and Brown Pelican. However, the data illustrate the common problem. From 1971 to 1975, during ecological and pollution-related studies of Brown Pelicans in the Gulf, we found that disturbances occurred more frequently than one would expect. For example, in five study areas we documented local disturbances over five consecutive years at two of the areas (Bahia de los Angeles area and Isla San Lorenzo area), and three years of five in the other three areas (Isla San Luis area, Puerto Refugio area, and Isla San Pedro Martir). Undoubtedly, the frequency of disturbance was even greater, for we did not cover all areas all the time. Such disturbances in most cases involved local, canyon-associated disruptions, but one party of observers has the potential to literally destroy thousands of nests, depending on when in the nesting cycle disturbance occurs. The most serious disruptions occur earlier in the nesting season,[31] especially for such species as the Brown Pelican. The disturbances we documented involved one to five known entries into nesting colonies over the breeding season by: sight-seeing American tourists on their own, sight-seeing American tourists guided by Mexicans, curious Mexican fishermen, commercial egg collectors,[32] and on two or more occasions, American scientists and educational tour groups. Tour groups usually represented many people wandering through the nesting colonies.

Human disruptions of the colonies can often ultimately result in significant reductions in final productivity (output of young at the end of the nesting season per nesting attempt) (50 to 100 percent in constant numbers of nests).[33] The normal situation of oceanographic change such as that observed in 1973[34] also results in occasional, normal nesting failures in the Gulf of California,[35] but human disturbance tends to reduce production of young in years when high production is needed.

Disturbance-induced reductions in productivity are usually caused by: (1) death of young birds due to heat exhaustion and injury (cholla cactus, falling off ledges, predation, etc.), (2) nest desertion by uneasy adults (this occurs most completely early in the nesting season), and

31. D. W. Anderson, unpublished data.
32. The eggs of seabirds that were less desirable for direct consumption were in the past popularly used as baking ingredients at bakeries in such places as Santa Rosalia and Ensenada, Baja California. One such operation was reported to us in 1972 when egg collectors took some 2000 eggs of pelicans off Isla San Luis.
33. *See* note 31 *supra*.
34. D. W. Anderson, *Gulf of California Sea Bird Breeding Failure*, Smithsonian Event Notification Report 1653 (1973). *See also* D. W. Anderson & I. T. Anderson, *Distribution and Status of Brown Pelicans in the California Current*, 30 Am. Birds 3-12 (1976).
35. *See* note 15 *supra*.

(3) egg losses to heat and more importantly to abnormal predation by gulls. Gull predation is part of the natural interaction in most seabird colonies. It occurs excessively in the presence of humans because the gulls are less afraid of man. Significant gull predation occurs only in the presence of man in the Gulf of California colonies, and gulls are also important and necessary components of marine bird communities. It is man that needs the management!

Because of its popularity, Isla Rasa is perhaps a key issue. One of the original purposes of the sanctuary was to provide security from egg-harvesting, as already stated. The prohibition of egg collecting has probably been quite effective. During our studies in the area, there were rumors almost every year of some egg collecting, but we do not believe this was significant.

In other regards, Rasa's three species are in a delicate situation. The Heermann's Gulls are subject to disturbance damages throughout the nesting season due to the territoriality and aggression of nesting adults. Young gulls are often killed (Figure 2A) when they wander or are disturbed into adjacent territories, or eggs are destroyed by neighboring gulls when the territory-holders are frightened off. If eggs are being incubated or the young are newly hatched, shading is often necessary during the midday sun. Disturbances at any stage of nesting can therefore result in reductions of productivity for both gulls and terns. Heermann's Gulls in addition act as predators on disturbed tern nests.

From 1971 to 1975, Rasa has had warden protection three years (1971-73). The year 1971 was one of excellent productivity,[36] and warden protection[37] combined with excellent ecological conditions to produce this situation. Since then, productivity has been lower,[38] and post-breeding age ratios have been alarmingly low since 1972. Age-ratios also reflect differential distribution of the age classes, but data are sufficient to demonstrate significantly low productivity after 1972. "Normal" breeding failure occurred in 1973 for most seabirds in the Gulf of California[39] and was not alarming in itself. It illustrates the additional variables and complications involved. Other factors such as pollutants in gulls and their eggs are also presently under investigation, but in 1974, we were able to document productivity (age-ratios) in areas with different degrees of disturbance on Rasa and another nearby island. Age-ratios (percent young-of-the-year in the nesting population at fledging) on a colony not believed to be

36. V. Velazauez-Nogueron, Aves Acuáticas Migratorias en Isla Rasa, B.C. (1969).
37. *See* note 28 *supra*.
38. *See* note 31 *supra*.
39. *See* notes 34 and 15 *supra*.

disturbed (Isla Cholluda) where 18 percent young. The same age-ratios in a moderately disturbed area of Rasa were 14 percent, and five percent in a heavily disturbed area of Rasa.[40] Some areas on Rasa in 1974-75 appeared as if "herds" of people had trampled through some nesting areas. In 1974-75, a sign in Bahia de los Angeles advertised tours to Rasa Island, five or six local fishermen set up a camp on the island, and several educational tours took people up onto the island. All indications were of multiple disturbances to the gulls and terns throughout each breeding season.

Pollution

We do not have the space to discuss thoroughly this potentially critical problem. However, our studies in the Gulf of California over the past five years with the U.S. Fish and Wildlife Service and Departamento de la Fauna Silvestre have been involved mainly with the study of pollution by organochlorine compounds and heavy metals.

Residue levels of organochlorines in fish from the southern part of the Gulf of California in another study[41] were believed to be remarkably low, and our samples of pelagic fish from the Gulf gave no indication of high residues.[42] Organochlorine insecticide residues in heron eggs (Ardeidae) were found, however, to increase somewhat to the south along the Mexican West Coast,[43] where rivers drain more significantly into the ocean (Figure 1). Residues of insecticides have been reported in clams from the region of the Rio Colorado,[44] but these were low (40 parts per billion or *ppb*) compared to, for example, residues in sand crabs from the California Coast (over 100 *ppb* in most cases, and near Los Angeles, as high as 8,000 *ppb*).[45] These residues for California were reported in 1971, and since then, there has been a significant decline in residues of DDT-related materials off Southern California, as well.[46]

Due to the present low water and sediment input of the Rio Colorado into the Gulf of California, we suspect this has not been an

40. *See* note 31 *supra*.
41. J. L. Cox, *Accumulation of DDT Residues in Triphoturus mexicanus from the Gulf of California*, 227 Nature 192-93 (1970).
42. *See* note 31 *supra*.
43. *Id.*
44. O. Nuñez-Esquer, *Concentración de DDT y Sus Metabolitos en Chione californiensis de la Parte Norte del Golfo de California*, 5 Congreso Oceanográfico 20-21 (1974).
45. R. Burnett, *DDT Residues: Distribution of Concentrations in Emerita analoga (Stimpson) along Coastal California*, 174 Science 606-8 (1971).
46. D. W. Anderson, J. R. Jehl, Jr., R. W. Risebrough, L. A. Woods, Jr., L. R. DeWeese, & W. G. Edgecomb, *Brown Pelicans: Improved Reproduction off the Southern California Coast*, 190 Science 806-8 (1975). *See also* D. W. Anderson, R. M. Jurek, & J. O. Keith, *The Status of Brown Pelicans at Anacapa Island in 1975*, 63 Calif. Fish Game (in press 1977).

important source of insecticide contamination for the Gulf. Potentially, because of the intense agriculture north of the Gulf of California, such as that found in the San Luis Valley of Sonora and farther north in the United States, the Rio Colorado could be a significant source of insecticide pollution. It would seem that a decline of nutrient input due to a decreased flow of the Rio Colorado may, however, create additional problems—another subject of concern at this conference.

Some of the seabirds that migrate out of the Gulf contain high residues of PCB (an industrial pollutant, polychlorinated biphenyl) and DDE (an environmentally stable metabolite of the insecticide DDT).[47] These probably come in large part from Southern California, but the residues from that source have now declined significantly since environmental actions were taken.[48]

We therefore believe that locally, at least in the northern part of the Gulf of California, pollution by insecticides is not the most pressing conservation problem. The aridity of the surrounding lands and general lack of agriculture (the San Luis Valley and areas west of Hermosillo being exceptions) on the lands surrounding the northern Gulf are probably the major reasons pollution by agricultural insecticides is not a problem of immediate concern. Farther south along the Sonora-Sinaloa coasts, and south, problems may be more acute and more pressing. Most drainage from agriculture in Baja California is toward the Pacific, and there more data are needed. More data are needed, as well, on the possible pollution by industrial sites such as that located at Santa Rosalia, Baja California.

Oil pollution seems to be a cause for future concern. For example, we know of two oil spills near Santa Rosalia in 1974. In the fall of 1974, we found significant numbers of oiled seabirds dead on the beaches south of Santa Rosalia; and, oil had reached the beaches of Isla Animas, the world's largest Brown Pelican nesting colony. We have seen an ever increasing number of oiled seabirds at such places as Guaymas, Sonora; Bahia de Kino, Sonora; Santa Rosalia; and even at Bahia de los Angeles, Baja California.

A deep-water port has been proposed for Puerto Peñasco, to unload crude oil and then to ship it via pipeline to Yuma, Arizona.[49] One major oil tanker spill in the Gulf of California has catastrophic potential for fish and wildlife, to say nothing of the potentially disastrous effects on tourism. Any such facilities and the movements of large amounts of petroleum materials in the Gulf of California should

47. *Id. See also supra* note 31.
48. *See* note 46 *supra*.
49. *Los Angeles Times*, Part III, 18 (7 Nov. 1973).

be seriously questioned by all who are interested in preserving the ecological balance of the Gulf.

Introduced Predators

Introduced predators, another age-old conservation problem, have the potential to exterminate local populations of nesting, insular birds. The effects of rats (*Rattus* sp.) have been well documented in other areas, and this mammalian predator seems especially harmful to the smaller, burrow- and cavity-nesting seabirds. A typical example of the effects of rat predation has been documented by Fleet.[50] Feral Cats (*Felis domesticus*) are also a potential hazard to nesting seabirds, especially those of medium and smaller sizes. Some examples of cat predation are cited by DeWeese and Anderson.[51] Whether cats can survive on most of the desert islands in the Gulf of California is open to question, especially on the smaller islands, but both cats and rats are known to occur on some of the islands (cats and rats on Isla Cerralvo;[52] both probably occur on most of the larger islands where fishermen have permanent camps; rats are on many of the islands, perhaps most: Isla Rasa,[53] Isla San Estaban, Puerto Refugio, Isla Alcatraz, Isla San Pedro Martir, and others).

Rats are probably not present on Isla Cardinosa which because of its large populations of petrels and Fishing Bats (*Pizonyx vivesi*, a unique mammal endemic to the Gulf of California[54]), is presently one of the islands most vulnerable to introduced predators. Once rats are introduced and established, there seems to be little hope of eliminating them. Therefore, prevention seems to be the best "cure."

Interactions with Commercial Fisheries

Presently, seabirds do not appear significantly in competition with any fishing operations in the Gulf of California. In Peru, intentionally large fishing catches reduced the resident marine birds to a very low population level,[55] but the fishery has since failed as well,[56] and has

50. R. R. Fleet, *Nesting Success of the Red-tailed Tropicbird on Kure Atoll*, 89 Auk 651-59 (1972). A less readily available reference which discusses the problems with introduced predators and petrel is: M. J. Imber, *The Rare and Endangered Species of the New Zealand Regions and the Policies that Exist for Their Management: Petrels and Predators*, 16 World Conf. Int. Council for Bird Preservation Agenda Item 17b(i) (1974).

51. L. R. DeWeese & D. W. Anderson, *Distribution and Breeding Biology of Craveri's Murrelet*, Trans. San Diego Soc. Nat. Hist. (in press 1976).

52. R. C. Banks, *Birds of Cerralvo Island*, 65 Condor 300-12 (1963).

53. *See* note 28 *supra*.

54. E. P. Walker, Mammals of the World, Vol. I 338 (1968).

55. M. B. Schaefer, *Men, Birds and Anchovies in the Peru Current-Dynamic Interactions*, 99 Trans. Am. Fish. Soc. 461-67 (1970). *See also* G. J. Paulik, *Anchovies, Birds and Fishermen in the Peru Current*, in Environment: Resources, Pollution and Society 156-185 (1971).

56. C. P. Idyll, *The Anchovy Crisis*, 228 Sci. Am. 22-29 (1973).

not yet recovered fully. Off California, overfishing was the major cause of the decline of the Pacific Sardine (*Sardinops caerula*),[57] but sardines were probably replaced largely by Northern Anchovies (*Engraulis mordax*).[58] These changes in the fish fauna off California were, however, not without some changes in the local marine fauna.[59] The California Current Region (the area off the West Coast of the United States and Baja California) presently supports huge numbers of transient seabirds,[60] from southern and northern waters, during late summer and fall; yet, the commercial fishery off the West Coast still largely produces a sustained, annual yield, with some exceptions.

Sardines declined significantly by 1969 in the Ensenada, Baja California area (as they had previously off California).[61] The sardine fleet of about 30 trawlers has since moved to the Gulf of California, and sardine landings have significantly increased there since 1970.[62] In some cases in the Gulf, presently seabirds consume "basura" fish thrown overboard. In this manner, and at certain times of the year such as during the post-breeding period, seabirds may even be benefited on a short-term basis from commercial fisheries. Presently, commercial fishing does not occur from June to September, when seabirds have the greatest demands on fish near the breeding colonies. Near most breeding colonies, feeding occurs independently. However, during the fishing season, some 700 trawlers discard some 700 tons of "basura" per day.[63] All the pelicans in the entire Gulf of California would consume less than 100 tons per day, a seemingly insignificant potential for competition with commercial fisheries.

The commercial fisheries-seabird competition question is often asked, but it is usually based on the all-too-simple question of the dollar-value or amount of fish consumed. Little regard is given to questions of ecological balance, nutrient cycling,[64] and to the more rapid recycling of less desirable fish by seabirds. More research is needed on (1) the total ecological roles of seabirds in marine

57. G. B. Talbot, *The California Sardine-Anchovy Fisheries*, 102 Trans. Am. Fish. Soc. 178-87 (1973).

58. G. I. Murphy, *Population Biology of the Pacific Sardine (Sardinops caerulea)*, 34 Proc. Calif. Acad. Sci. 1-84 (1966).

59. D. G. Ainley & T. J. Lewis, *The History of Farallon Island Marine Bird Populations, 1854-1972*, 76 Condor 432-46 (1974). *See also* Ainley, *The Occurrence of Certain Seabirds in the Nearshore California Current Region of California*, Western Birds (in press 1976).

60. *Id.*

61. A. Hernandez, Estación de Biologia Pesquera, Mazatlán, personal communication.

62. *Id.*

63. *Id.*

64. L. M. Tuck, The Murres (1960). *See also* R. C. Murphy, The Oceanic Birds of South America, Vol. I (1936).

ecosystems, such as recently reported off the Oregon Coast[65] (but considering nutrient cycling and other factors), and (2) on the potential consequences of overfishing to the marine life of the entire Gulf of California. Nutrient and energy input by seabirds are probably significant in systems such as the Gulf of California, as suggested for some other areas.[66] Estimating the economic value of seabirds on the basis of amount consumed only may be a serious mistake.

Reduction fisheries, which potentially use most of commercial fishing takes regardless of species or size of fish, seem to be the greatest threat to seabirds regarding fisheries interactions. Reduction fisheries or excessive harvests on "key-industry" species (those at or near bases of food-webs) such as sardines and anchovies, other pelagic fishes, and invertebrates such as *Pleuroncodes planipes*, would seem to potentially result in ultimate reductions of many desirable predatory fish, seabirds, and sea mammals. Seabirds likely respond to overfishing, and therefore they could probably act as valuable indicators of the conditions of commercial stocks.

SUGGESTIONS FOR CONSERVATION

Our review has been brief and sketchy, but we hope we have conveyed the ideas that: (1) seabirds are worthy of conservation effort, (2) marine bird conservation can only be a part of a larger conservation program oriented toward unique biological areas and interacting marine-estuarine ecosystems, and (3) there are needs for conservation of marine ecosystems in the Gulf of California *now*. The adverse effects of man are likely to increase in the near future if something is not done *now*. Development of fishery and mineral resources is inevitable, but it must be encouraged to proceed in an orderly and least-damaging manner as possible.

Conservation responsibility ultimately falls on federal and state governments, and we must encourage our governments to engage in such programs. Support of private organizations such as Bioconservacion, Pacific Seabird Group, National Audubon Society, and others can also help bring this about.

Marine and estuarine ecosystems, associated islands, vegetation, and wild areas should be included in the conservation programs of the Mexican government. A program in the Gulf of California should involve marine mammals, marine birds, islands, and island flora and fauna, and perhaps even sport fisheries in addition to hunting. The

65. J. A. Weins & J. M. Scott, *Model Estimation of Energy Flow in Oregon Coastal Seabird Populations*, 77 Condor 439-52 (1975).
66. *See* note 64 *supra*.

international cooperation already initiated between Mexico and the United States should be continued and expanded, since so many of the resources are truly international.

A "sanctuary" system as proposed in part by Lindsay[67] should be expanded to include additional islands (Table 3). Islands can be established as sanctuaries (like Isla Rasa) and yet most can still provide anchorages and offshore fishing and diving, etc. Island sanctuaries also include the preservation of unique terrestrial fauna and flora. An "Island National Park" established for the preservation of fauna and flora, yet providing controlled access in nonsensitive areas, does not seem out of the question. Ideally, all offshore islands in the Gulf of California that are not presently inhabited could be placed under sanctuary status.

As a first step, unostentatious bilingual signs could be placed at access points, at anchorages popularly used, and at sensitive points near important breeding areas for seabirds, hauling out areas for sea mammals, etc. Important bays and beaches could in most cases still be used by fishermen and boaters. Unmanaged tourism is a current and potentially serious problem, but eventually, established trails and observation points in nonsensitive areas could be established. As funding develops, a sea-going warden patrol and research vessel should be established. The islands and surrounding areas can also provide Mexican and American students with unique opportunities to study marine ecosystems.

The Department of Tourism in conjunction with Fauna Silvestre should perhaps develop a pamphlet to be made available to tourists entering the country that makes tourists aware of the wildlife and flora of the Gulf of California area (and for other areas of Mexico) and asks for care in their preservation. Numerous American and Mexican organizations would likely aid in the preparation of such pamphlets and in the development of signs and proper wording for placement on the islands.

We suggest that Mexican and American scientists continue to keep abreast of seabirds and other marine fauna in the Gulf of California as possible indicators of overexploitation. Seabird populations need to be monitored for long-term population data to help understand normal fluctuations and their relationships to commercial fisheries. Most importantly, seabird and sea mammal researchers need to begin to closely work as research teams with fisheries biologists and oceanographers, so that estimates can be made of the total ecological situation in the Gulf of California.

67. *See* note 14 *supra*.

TABLE 3

Islands in Need of Sanctuary Status for Nesting Seabirds in the Gulf of California if Priorities Need to Be Set

Priority[1]	No.[2]	Island Name(s)	Particular Conservation Problem	Uniqueness
1	2	San Luis-Cholluda	Human pressures, nearness to land, many boats, egg collectors; San Luis is compatible with limited access.	A major Brown Pelican nesting colony, Ospreys, boobies, Heermann's Gulls, and other seabirds, lava formations, spectacular scenery.
1	3	Pelicano-Granito	Human pressures, easy access, area is a popular concentration point for boaters; these two islands are incompatible with human intrusions.	Brown Pelicans, major sea lion area, unique cardone forests, Ospreys and other seabirds in area, spectacular scenery.
1	4	Smith-Ventana-Gemelos-Piojo	Extreme human pressures, easy access, camping, boating, exploring; some areas are compatible with limited access.	Many Osprey, cormorant nesting (both species), burrow-nesters, many seabirds in area, cetaceans in area, spectacular scenery.
1	6	Entire Midriff Complex	Popular anchorages, much onshore exploring, area of some small commercial fishing operations, compatible with offshore fishing activities, some areas are compatible with onshore activities.	Major seabird concentrations in Gulf, Partida is largest petrel concentration in Gulf, San Lorenzo area has world's largest Brown Pelican colony, Ospreys, cormorants, Western Gulls, pinnipeds, cetaceans, unique terrestrial flora and fauna.
2	6	San Esteban	Large island not immediately vulnerable, though unique, highly desirable as a sanctuary.	Unique terrestrial flora and fauna, seabirds, nesting on outer edges, Seri studies, spectacular scenery.
1	7	San Pedro Martir	"Scientific" tours, difficult access, however, still high priority due to beauty and uniqueness.	Outstanding flora and local fauna, historical guano village, boobie-pelican and other seabird nesting, pinnipeds, spectacular scenery.
2	8	San Jorge	Difficult access and not as currently popular as Midriff.	Boobies, Heermann's Gulls, scenery.
1	10	Alcatraz	Very close to tourist area, much disturbance, proposed development, lower beaches available for limited access.	Burrow-nesting seabirds, Osprey, night herons, largest Double-crested cormorant colony in Gulf, scenery.
2	11	San Pedro Nolasco	Close to major tourist area, but difficult access.	Onshore vegetation, large seabird concentrations, pinnipeds, spectacular scenery.
2	12	Tortuga-Santa Inez	Difficult access, but close to popular tourist areas, not immediately threatened.	Large pelican-boobie nesting area, spectacular scenery, extinct volcano, unique terrestrial fauna and flora.
1	13	San Ildefonso	Difficult access, but a popular area for boaters.	Unique flora, spectacular scenery, many seabirds of various species.
2	14	Danzante-Monserrat-Santa Catalina	Difficult access except Danzante, near very popular tourist areas.	Spectacular scenery, pinnipeds, cetaceans, large concentrations of various seabirds, unique flora and fauna.

1. Rated as follows: 1 = immediate need as a sanctuary, 2 = needs sanctuary status in the near future. Other islands and unique areas should be added to this list as more data become available.

2. This number corresponds with Figure 1 and Table 1.

NOTE: The status of islands in areas 14-20 is not well known and more work is needed to determine their vulnerability and priorities for conservation. In addition, there are at least three major seabird colonies in the mangrove areas that rate priority 1: unnamed islands at 2507-10818 (latitude-longitude), 2429-10833, and 2358-10702.

A critical question now is perhaps: "Where is all the money coming from?" For immediate needs such as signs, pamphlets, and warden support on Rasa, American agencies and conservation groups can be encouraged to help continue to support such activities. A fund source ultimately needs to be developed and expanded in Mexico; and, tourism, boating, hunting, and sport fishing may have to eventually pay the bills. Hopefully, the importance of the Gulf of California to tourism will encourage the Mexican government to include marine fauna and flora in their overall conservation programs. The starts outlined by M. L. Cossio[68] are encouraging. Environmental groups in Mexico should urge their government to provide more appropriations to federal wildlife agencies; and, they should encourage more support for conservation-, biological-, and pollution-related research by Mexican universities.

We believe that marine ecosystems—in addition to purely harvestable resources—are worthy of serious consideration. The Gulf of California is a resource that should be looked upon for the future.

RESUMEN

El Golfo de California contiene uno de los grupos más grandes y más ricos de aves subtropicales de Norteamérica. Además, existe una abundancia de aves transitorias durante ciertos períodos del año. Estas aves marinas son parte del gran sistema de vida marina, islas, singular vegetación y belleza espectacular que merece intensos esfuerzos de conservación. Existen muchas razones que justifican la conservación; las más importantes son: 1) Los valores estéticos y turísticos, 2) El equilibrio ecológico, 3) El ciclo de materiales nutritivos.

Entre los problemas de conservación actuales o posibles, se encuentran los siguientes:

1) Alteración de colonias de aves de procreación anidando.
2) Contaminación.
3) Depredadores introducidos.
4) La posibilidad de rivalidad entre la pesca comercial excesiva y la conservación.

Las medidas de conservación que se mencionan son las siguientes:

1) La integración de los ecosistemas marinos en el programa mexicano de conservación.

2) Un sistema de refugios o islas nacionales en áreas críticas con patrullas de protección y para la recolección de información, control de acceso; turistas permitidos solamente en sitios que no estén apeligrados.

68. *See* note 11 *supra.*

3) Publicación de folletos y otros materiales informativos por las Agencias Federales de Fauna Silvestre y de Turismo.

4) Continuación de los estudios científicos, especialmente aquellos relacionados con aves marinas como índices de contaminación y sobrepesca.

5) Estudios para establecer la función ecológica de aves marinas en el ambiente del Golfo de California.

6) Establecimiento de recursos financieros para la conservación del Golfo de California inclusive el deporte de la pesca como fuente de ingresos.

7) Un aumento de apoyo a las agencias de Fauna Silvestre y a las universidades en México.